Letters to the Editor

Indian J. Phys. **49**, 327–329 (1975)

Output impedance of silicon diffused planar transistor

R. N. Singh

Department of Physics, University of Gorakhpur, Gorakhpur 273001

(*Received* 14 *November* 1974)

Output impedance plays an important role in modifying the frequency response of various transistorized electronic circuits. Frequency dependence of output impedance for alloy and grown junction transistors has already been studied by various workers (Lo 1955, Pritchard 1953 and Srivastava *et al* 1963). Their study regarding output impedance mainly concerns at very low injection level. But as yet no adequate experimental study of output impedance for planar junction transitors at useful injection level is available in literatures. This research note reports the dependence of output impedance of silicon diffused planar junction transistors on injection level under both normal and inverse (*i.e.*, when emitter collects and collector omits) operating conditions.

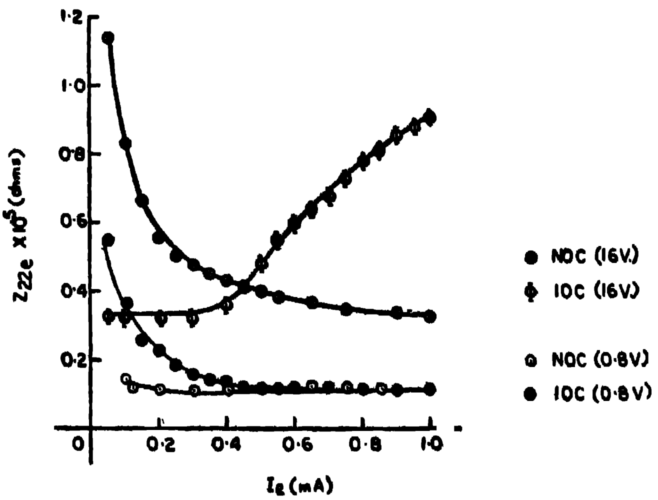

Fig. 1. Variation of output impedance, Z_{22e}, with emitter current for the silicon diffused planar transitor type CIL911.

The output impedance was measured with the help of a suitable circuit (Lo 1955). Figure 1 depicts the Z_{22e} (output impedance in common emitter configuration) vs. emitter current for the *n-p-n* silicon diffused planar transistor CIL 911 at a constant collector reverse bias of 0.8V and 16V. A large number of planar transistors namely CIL 531, CIL 511, CIL 553, CIL 701, CIL 711 and CIL 901 have also been studied and was found that they possess the identical behaviour.

The output collector-emitter impedance in common emitter configuration in the medium frequency region is given by the relation,

$$Z_{22e} = r_0 + \frac{k}{2\pi f C_T}, \qquad \ldots \quad (1)$$

where k = a constant, f = operating frequency, C_T = reverse biased collector junction capacitance and r_0 = current dependent resistive component. It is clear from eq. (1) that the Z_{22e} consists of two terms, the first is resistive component and the second is capacitative component.

Output Impedance Below Breakdown Region

(a) *Under Normal Operating Condition*

In silicon diffused planar transistor, the transition layer capacitance, C_T, when operated under NOC is small. If the operating frequency is also low, the capacitative term of eq. (1) is very high in respect of resistive term. Hence eq. (1) reduces to,

$$Z_{22e} = \frac{k}{2\pi f C_T}. \qquad (2)$$

From eq. (2) one can easily conclude that the output impedance is independent of injection level and is in good agreement with the experimental result.

(b) *Under Inverse Operating Condition*

Under this condition the transition layer capacitance becomes very large (*i.e.*, approx. 5 times larger than that of NOC (Prasad & Misra 1969)). Due to this the contribution of capacitative term in respect of resistive term is negligibly small. Since resistive term varies inversely with the injection current, so the collector-emitter impedance will also vary inversely with the injection current. As it can be seen from the figure, the agreement between theoretical and experimental result is good.

Output Impedance Beyond Breakdown Region

(a) *Under Normal Operating Condition*

In the breakdown region and under NOC the junction capacitance is increased very much due to the introduction of free carriers in the depletion layer (Abdullayev 1966). Because of this increased nature of C_T in breakdown region, the contribution of capacitative term towards the Z_{22c} is small under this condition in comparison to that of resistive term. And hence Z_{22c}, varies inversely with emitter current.

In order to check the validity of this agreement Z_{22c} under this condition has been measured and has been shown in the same figure. The experimental result justifies this agreement.

(b) *Under IOC*

The nature of Z_{22c} under IOC in the breakdown region is not very much clear. From the figure it is clear that Z_{22c} remains constant upto 0.4 mA and increases more or less linearly with emitter current afterward. It appears that the complication arising from the injecting surface under IOC plays an important role towards the formulation of the output impedance in breakdown region. A thorough study regarding the mechanism of injection of minority carriers from the emitter (previously which was collector) is essential for explainning the observed result which is in progress and will be communicated later.

References

Abdullayev G. B. 1966 *Radiotechk electron* **11**, 1336.
Lo 1955 *Transistor Electronics*, Prentice Hall, p. 231.
Misra M. & Prasad H. C. 1969 *Solid State Electronics*, **12**, 521.
Pritchard R. L. 1953 *Proc. I.R.E.* **41**, 1060.
Srivastava G. P., Misra M. & Tripathi K. 1963 *Z. für angewandte Physik* **15**, 5139.

Indian J. Phys. **49**, 329–331 (1975)

Absorption spectra of 2,6-xylenol

A. K. Sarkar and D. Marjit

Optics Department,

Indian Association for the Cultivation of Science, Calcutta 700032

(*Received* 29 *November* 1974)

In two earlier papers were reported the electronic spectra of 2,4-xylenol (Marjit 1970) and 3,5-, 2,3- and 2,5-xylenol (Marjit & Banerjee 1974). In this note the absorption spectra of 2,5-xylenol are described.

Chemically pure sample of 2,6-xylenol obtained from Fluka AG, Switzerland, was purified by fractional and vacuum distillation before use. The experimental arrangements for photographing the ultraviolet absorption spectra of 2,6-xylenol